PSY/NEU338
Animal learning and decision making: Psychological, Computational and Neural Perspectives

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Introductions

- PART I - about you
- PART II - about this course
- PART III - about learning, decision making & computational neuroscience

Part I:
About you

- who are you?
- what are you hoping to learn here?
  - "I would like to learn how to…"
  - "I am hoping to learn about…"

who am I?

Professor of Neuroscience and Psychology

Background: computational neuroscience, animal & human learning, decision making

I am interested in understanding learning and behavior as we know them in daily life: how is it that we adapt so well to a changing environemnt? And how the brain brings this about?

Methods I use in my research: computational modeling, human behavior and fMRI experiments (rodent experiments)

PART II:
about this course

course structure & outline

- Each week will concentrate on one topic, approaching it from three perspectives:
  - ✓ psychology
  - ✓ computational models
  - ✓ neuroscience
- weeks 2-7: fundamentals, classical and instrumental conditioning
- winter break
- weeks 8-13: 'advanced topics' (current list is tentative)

what is the point of this course?

Thinking of what you want to get out of your college education *and* this course, which of the following is *most* important to you?

1. Acquiring information (facts, principles, concepts)
2. Learning how to use information and knowledge in new situations
3. Developing lifelong learning and analytical skills

Learning about learning

All three goals are clearly important... but how best to accomplish them?

Learning is not a spectator sport—it takes work (this includes work in the classroom and work that you do outside of the classroom)

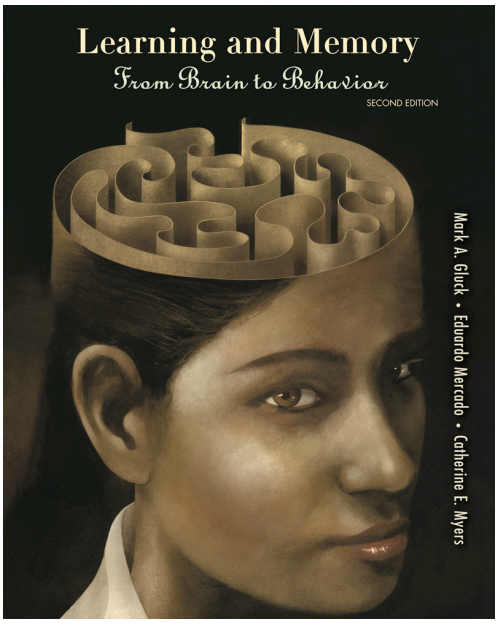
So, of these three goals, which do you think you can make headway on outside of class by your own reading and studying, and which do you think would be best achieved in class working with your classmates and me?

What is *your* learning style?

the questionnaire I gave you came from:
http://www.ncsu.edu/felder-public/ILSpage.html
please fill this at home and we will discuss it on Tuesday

a word about our textbook

- This is a well-written, interesting book (learning in everyday life, clinical perspectives etc.)
- That said, the book is a resource for you… I will not repeat the book in class, nor will everything that I teach be covered in the book. However, it lays out the background for what we discuss in class
- Relevant chapters:
  1-3 introduction
  4-5 basic learning
  6,10 two of our advanced topics



other course materials

- handouts will be made available in class for taking notes
- these are small.. I am trying to save trees (you still need a notebook); take one only if you are going to use it
- oftentimes I purposefully leave things out
- sometimes we don't cover all the slides in the handouts
- don't let that stress you out!
- slides *true to what we actually discussed* will be posted online after class on the class website (next slide)

online resources

tip: to find the website: go to my personal or lab websites (google: Yael Niv) and it is linked there

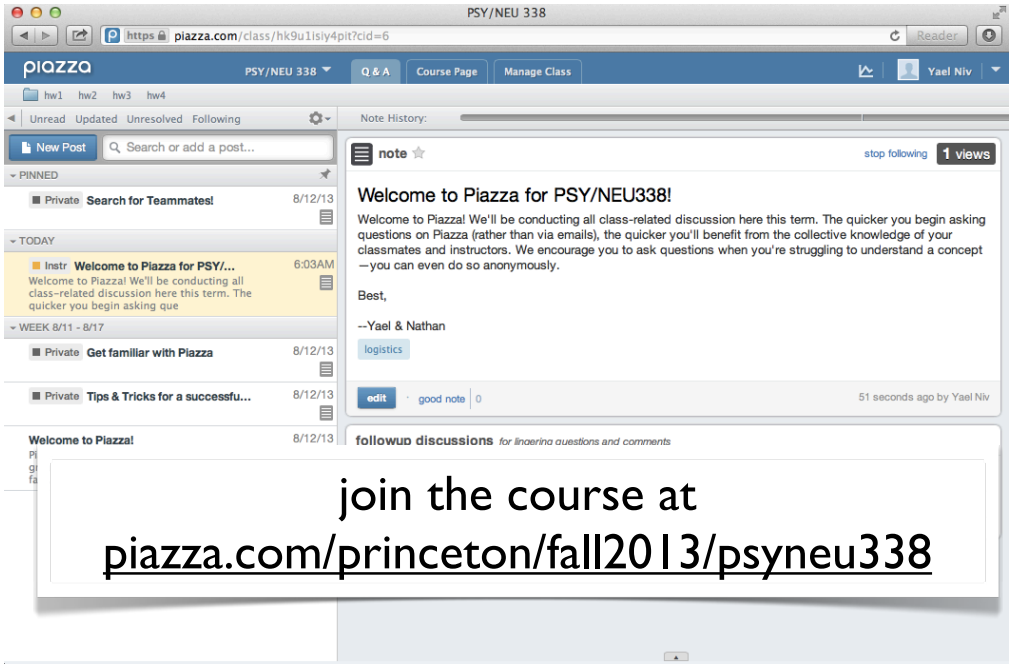
requirements & grading

- active participation (10% total, 5+5 class & precepts)
  - ask questions often
  - critical & constructive thinking
  - activities in class
  - piazza
- precepts (10%)
- assignments (40%)
  - reading + problem sets (30%) [best N-1]
  - programming (Matlab) (10%)
- final exam (40%)
- you *should not* be here if:
  - you are looking for an easy grade
  - you are looking for a course in cognitive psychology/ cognitive neuroscience/ neuroeconomics/ machine learning
  - you are looking for a self-help course on decision making/learning

what I expect of you...

- keep abreast with the class: reading material, assignments, class notes
- be inquisitive/curious: ask questions
- be a scientist: critical & constructive thinking
- be awake: activities in class
- join us for coffee/tea/hot chocolate break at least once in the semester (for free! ☺)
- please: no laptops

participation through piazza



help us slay the email monster… email us directly only for:

1. scheduling a meeting
2. personal questions that are of no interest to others

But first, please ask yourself:

- does this question really need an answer? (if YES then..)
- do I already know the answer? (if NO then..)
- can I find the answer somewhere else? (if NO then..)

Be patient. We get a lot of email.

(hint: there is rarely a question that does not interest any of your classmates and satisfies the three criteria above)

PART III:
about learning, decision making & computational neuroscience

why do we have a brain?

My answer: To behave

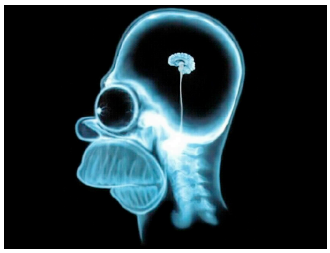
Example: the sea squirt (tunicate)

larval stage: primitive brain & eye, swims around, attaches to a rock
adult stage: digests brain. sits.

Credits: Daniel Wolpert

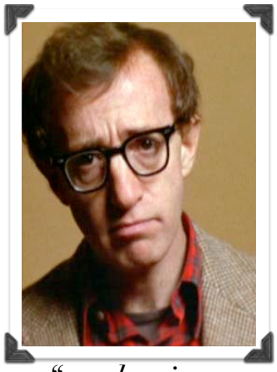
the ultimate goal

brain ⟷ behavior



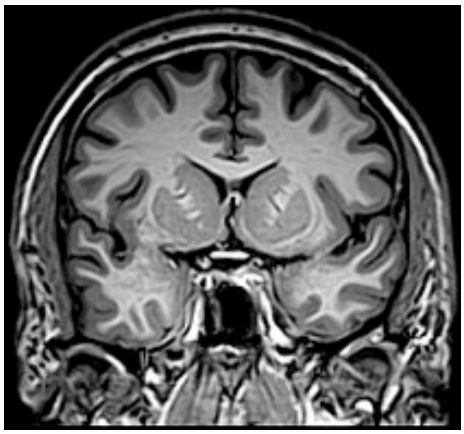
unfortunately...

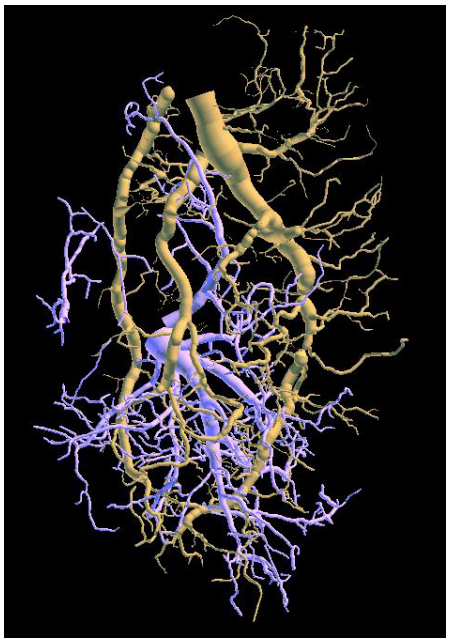
- The brain is an extremely complex (and messy) dynamic biological system
- 10^{11} neurons communicating through 10^{14} synapses
- And, to boot, behavior is really messy and complex!
- We haven't got a chance...
- What to do??



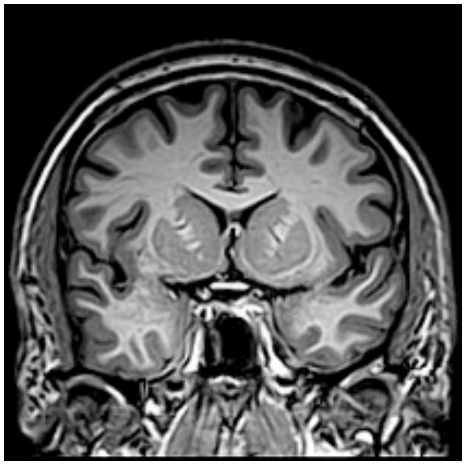
"my brain… that's my second favorite organ"
- Woody Allen

idea: from structure to function

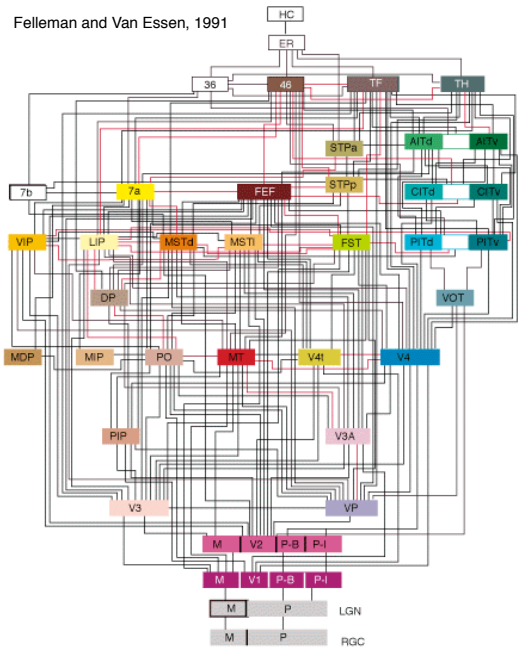




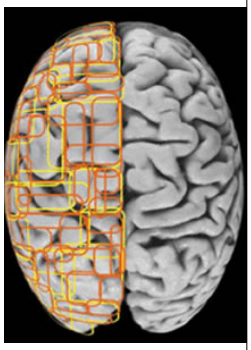
hmm...



Felleman and Van Essen, 1991

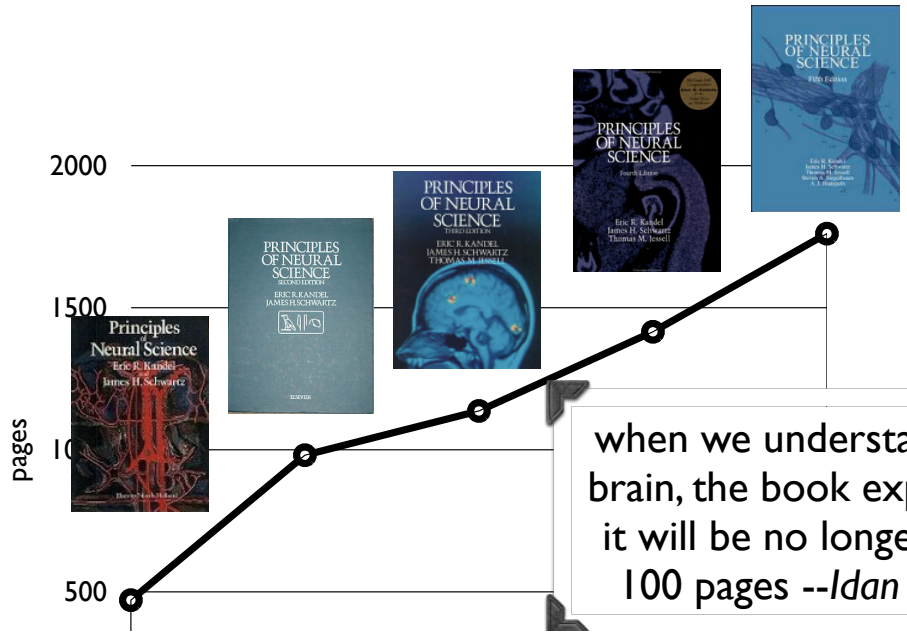


why should we care about computational models?



(relatively) New Idea:

- The brain is a computing device
- Computational models can help us talk about functions of the brain in a precise way
- Abstract and formal theory can help us organize and interpret data



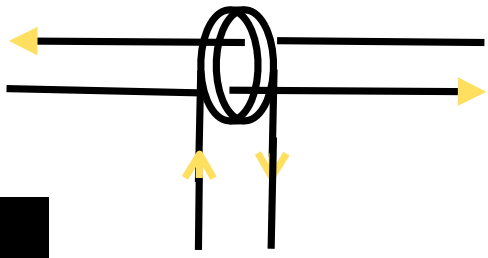
THE TASK OF NEURAL SCIENCE is to understand the mental processes by which we perceive, act, learn, and remember

OUR TASK is to make this book shorter!

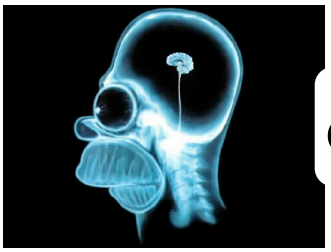
Describing ≠ Understanding

Credits: Daniel Wolpert

brain



behavior



computation

$\delta(t)=r(t)+V(t+1)-V(t)$

who am I and why am I here?

My background is in computational neuroscience

The questions that interest me most come from psychology (behavior): how do we learn to behave in the real world?

I view the brain as a computational device that solves (pretty efficiently) the problems that the world throws at it.

So to understand behavior at a systems level I ask: what are the computations that the brain needs to realize in order for learning and behavior to be as they are?

PSY338/NEU338 - Animal learning and decision making: Psychological, computational and neural perspectives

- What is "learning"
- What do I mean by "decision making"

What is "learning"?

- new behavior
- does it have to be new? what about learning to avoid an old behavior?
- change over time
- change dependent on experience (rather than mere maturation)
- not temporary (fatigue, habituation)
- behavioral change? latent learning?
- does it have to be adaptive? (superstitions, learned mental disorders, e.g., anorexia [thanks for the idea!])
- does it have to be declarative? intentional? (implicit learning of the order of songs in a CD)

What is "learning"?

non-temporary change in the behavioral mechanisms engaged in a certain situation...

...that results from repeated experience with the situation...

...and providing the change can't be explained in terms of innate behavioral tendencies of the organism

Credits: Daphna Joel 29

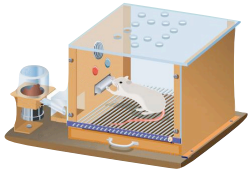
what do I mean by "decision making"?

some things that are often called decision making:

- PSY: judgement and reasoning (biases, heuristics)
- NEU: perceptual decisions & decision processes
- ECON: financial decisions (explicit, behavioral economics)

- Here: mostly implicit decisions, based on trial and error learning, similar in animals and humans

green



Credits: Nathaniel Daw 30

what do I mean by "learning and decision making"?

- ✳ we will not be interested in learning of muscle movements etc. *how* to do things
- ✳ we will be interested in learning *what* to do, *which* of several motions to make, that is, learning to make decisions